Science Brief: Prevention and Control of Respiratory and Gastrointestinal Infections in Kindergarten through Grade 12 (K-12) Schools

PURPOSE

The general science of infection prevention and control can be applied to and adapted for a variety of settings, including kindergarten through grade 12 (K-12). Strategies can be implemented in the classroom and whole school environment to prevent a wide array of illnesses caused by both bacteria and viruses. This science brief presents findings from a review of research studies focused on school-based strategies to prevent and control respiratory and gastrointestinal infections. The studies reviewed in this brief informed and supported development of the Guidance for Preventing Spread of Infections in K-12 Schools. Previous literature reviews[1-6] have been published about infection prevention in schools, and most have focused on single intervention strategies such as hand washing, cleaning and disinfection, or contact tracing. Additionally, CDC has evidence-based guidance, including the respiratory virus guidance that was taken into consideration when developing this brief. This science brief adds to existing literature by describing the current state of science for a comprehensive set of strategies to prevent spread of respiratory and gastrointestinal infections in K-12 settings.

BACKGROUND

In the United States, respiratory (e.g., influenza, COVID-19, streptococcal pharyngitis) and gastrointestinal (e.g., norovirus, rotavirus) infections are frequent causes of illness among children and adults. These infections are frequent causes of absenteeism for students and missed work for school staff..,

Schools are an important place where children learn, socialize, and play, and are connected with students' families, community health and social services, and local and state governments and workplaces. Developing, regularly updating, and implementing a school health plan, including measures to prevent and control respiratory and gastrointestinal infections, can help schools limit the spread of disease and reduce student and staff absences from school due to infectious diseases. Prior to COVID-19, illness-related school closures rarely occurred, representing approximately 1% of all unplanned closures over a 2-year, non-pandemic period.[7] Of these closures, the majority were due to respiratory (59%) or gastrointestinal (20%) illness

Minimizing illness and student absences from school also means maintaining student access to other important school services (e.g., meals, speech therapy, etc.), protecting students' and staff's families and communities from infection, and preventing parents and other caregivers from missing work to care for a sick child.[8-10] This science brief identifies evidence-based strategies to prevent and control infectious diseases within school settings.

METHODS

Study Selection and Search

After establishing a set of key words (Table 1), a comprehensive literature search strategy using Google Scholar and PubMed databases was conducted. The search yielded a total of 1659 articles that were imported into the Covidence systematic review software program. Title and abstract screening processes were then conducted using the inclusion criteria outlined in Table 2, resulting in a total of 449 abstracts that were moved forward for full-text review. The full-text review process yielded 158 articles that met inclusion criteria. These articles moved forward to the extraction phase and are included in this review. (See PRISMA flow diagram in Appendix A).

Table 1: Key Words for Literature Review		
School and…		
infection control /prevention	respiratory disease	ventilation
absence and infection	mitigation	illness exclusion or absence for illness
disease transmission	mask wearing	disinfection or cleaning
gastrointestinal disease	hand washing	vaccine or vaccine promotion

Table 2: List of Study Inclusion Criteria	
Publication Type	Peer-reviewed journal articles
Publication Date	2009–2023
Study Countries	United States, Canada, United Kingdom, European Countries, Australia, and New Zealand
Publication Language	English only
Setting	School-based
Participants	K-12 school students, staff, and parents/guardians
Study Design	Randomized controlled trial, quasi-experimental, case-control, cohort, cross- sectional, mixed methods
Study Aims	The study examines an association between a school-based prevention strategy or intervention and 1) respiratory or gastrointestinal infection or 2) absence rate outcome among school staff or students.

Full Text Article Data Extraction

Two reviewer extracted information from each of the 158 articles that met inclusion criteria, using an extraction form created in Covidence that included 28 items to reflect details about each article. These were organized into six categories: 1) guiding questions, 2) study citation information, 3) intervention setting, 4) intervention description, 5) study sample size and demographics, and 6) study design and findings. The information extraction form is found in Appendix B. Reviewers then reconciled full text article information extraction differences, establishing consensus for any conflicts. The extracted information from each article was then exported from Covidence to Microsoft Excel for synthesis of findings across the included studies.

FINDINGS: Overview

Of the 158 articles reviewed, 93 were conducted in the U.S. and 65 in other countries. The studies were focused on prevention and control of COVID-19, influenza, other respiratory infections, gastroenteritis, and/or school absence due to one of these infections. An increase in school-based infection prevention and control studies was seen during the COVID-19 pandemic. COVID-19 was the focus of 105 articles, 47 articles focused on influenza and/or other respiratory illnesses (e.g., pertussis), and gastrointestinal illnesses were the subject of 6 articles. The following are the major categories of infection prevention and control strategies identified and included: testing, symptom monitoring, contact tracing, hand hygiene (hand washing/hand sanitizing), mask wearing, physical distancing, respiratory etiquette, surface cleaning and disinfection, ventilation improvements, vaccination, school closure, staying home when sick, and multicomponent approaches. Each of these strategies is briefly described in Appendix C along with the number of articles that included the strategy. More often than not, schools implemented multiple IPC strategies; however, not all strategies were assessed for effectiveness within the study. For example, a study may have looked at the effect of modified quarantine for a student exposed to an infection and may have also had other IPC measures in place at the school, such as mask-wearing and physical distancing, that were not evaluated. Findings are presented by specific IPC strategy. Overall findings are synthesized, followed by examples of studies to provide more detail about the effectiveness of the IPC strategy in reducing transmission of illness or reducing school absences or both.

FINDINGS: Infection Prevention and Control Strategies

Findings presented below are categorized by layered or multicomponent interventions, followed by sections for single IPC strategy sections. Most studies in this review implemented multicomponent or layered interventions. The sections on specific, singular IPC strategies reflect findings that either only focused on that single strategy or were the main strategy of interest in a multicomponent intervention.

Layered or Multicomponent Intervention

Summary of Findings. The majority of the studies included in this review implemented a multicomponent strategy or layered approach for the prevention and control of infectious disease.[11-75] These studies described two or more infection prevention and control strategies that were implemented to reduce infectious disease(s) in a school setting**.**[32,43,45,52,70,76-78] Ganem et al. investigated prevalence and determinants of SARS-CoV-2 infections in Catalonia, finding low transmission among children and highlighting the importance of addressing socioeconomic factors and compliance with sanitary measures.[25] Kaiser et al. observed adherence to mitigation policies in San Francisco community school hubs, reporting minimal transmission despite variable adherence to guidelines, emphasizing the effectiveness of multiple mitigation strategies.[34] Zhang et al. modeled the impact of nonpharmaceutical interventions in U.S. K-12 schools, highlighting the effectiveness of masks, reducing contacts, and screening tests in reducing COVID-19 incidence, while cautioning about the potential increase in absenteeism with certain interventions.[70] In a large nationwide survey of adults with at least one school aged child in the household, there was a positive association between in-person schooling and testing positive for COVID-19 when there were low levels of mitigation measures; but, when seven or more mitigation measures were reported, a significant relationship with COVID-19 was no longer observed.[40]

A study from Norway showed that children had a limited role in the transmission of COVID-19 and were rarely index cases, especially when schools implement layered, non-pharmaceutical interventions (NPI).[79]

Overall, these studies indicate that layering multiple IPC strategies may facilitate the creation of safer environments within educational settings. Evidence-based multicomponent strategies or layered approaches may also play a role in mitigating infectious disease outbreak transmission. By implementing multicomponent strategies or layered approaches, schools can substantially reduce the risk of infectious disease and safeguard the well-being of students, staff, and families.

Hand Hygiene (Handwashing and Hand Sanitizing)

Summary of Findings. Studies that assessed the effectiveness of hand washing and/or the use of hand sanitizer reported reductions in the transmission of infectious pathogens and reduced absenteeism.[80-88] While hand hygiene was included in most of the multicomponent interventions, it was studied as a single intervention strategy in several studies. A number of studies showed evidence that using hand sanitizer can be effective at reducing transmission and can further the impact of handwashing on transmission.[58-60,65,80-82,84] One study showed that students who washed their hands with soap and water and followed up with hand sanitizer had a lower risk of absenteeism due to gastroenteritis compared to students who followed the usual handwashing procedure.[80]

Some studies described several factors that can increase the effectiveness of a hand hygiene intervention. Education about handwashing, including monitoring and real-time correction of ineffective techniques, is one approach used.[44,84,87] Assessing the effectiveness of health education in combination with hand hygiene was conducted with younger children in some studies. For example, a team of English researchers applied the Capability, Opportunity, Motivation, Behavior model (COM-B) to develop a multi-component handwashing intervention called “Germ’s Journey” for young school children.[87] The intervention, implemented by teachers, included health education lessons and activities. As compared to the control group, students in the intervention group improved their understanding of germtransmission, handwashing frequency, and handwashing quality. In another study of Chicago elementary schools during peak influenza season, students in the intervention group received hand washing supplies and hand sanitizer as well as short repetitive instruction in hand hygiene every two months.[84] The control group only received hand washing supplies and hand sanitizer. The researchers observed that total absent days and illness-related absent days were significantly lower in the intervention group during the influenza season. In summary, these studies indicate that hand hygiene—whether through hand washing or use of hand sanitizer—plays a critical role in reducing the transmission of infectious pathogens and minimizing absenteeism. Combining education with proper hand hygiene practices further enhances its impact, especially among younger populations.

Respiratory Etiquette

Summary of Findings. Respiratory etiquette, which involves covering one’s mouth /or nose while coughing or sneezing, was used as one of the components in multilayered infection prevention strategies. No studies in this review evaluated the effectiveness of respiratory etiquette as a standalone strategy. This strategy is often coupled with hand hygiene instruction to help reduce the spread of respiratory viruses such as influenza and COVID-19. A study of Pittsburgh area elementary school students found that an educational program that emphasized respiratory etiquette showed reductions in lab-confirmed influenza A cases and total school absences.[60] Other studies examined the acceptability and uptake of interventions that included respiratory etiquette.[56,57,59,61] Studies found that teachers and caregivers were receptive to instructing children on respiratory etiquette as a NPI, with one study showing 90% uptake among these groups.[57] Another study found that respiratory etiquette was found to be acceptable based on the ease of uptake and practice compared to more intrusive NPIs.[59]

Surface Cleaning,

Summary of Findings. Evidence-based surface cleaning strategies for K-12 schools mitigate infectious disease transmission.[89,90] Surface cleaning was primarily identified in multicomponent intervention studies; however, some did assess its effectiveness exclusively. These strategies emphasize regular cleaning with soap and water or appropriate cleaning products, focusing on high-touch areas like doorknobs and countertops. Studies have found that many common viruses, such as adenovirus, rhinovirus, and coronavirus, can be found on high-touch classroom surfaces.[90] A study examining the effectiveness of surface cleaning in elementary schools found that students in classrooms that were disinfected daily were less likely to report absenteeism due to illness compared to control classrooms.[89] Implementing surface cleaning strategies enhances safety within educational settings, reducing the risk of infectious disease transmission.

Vaccination

Summary of Findings. Vaccination is an effective, well-established public health strategy.[91-116] Vaccination reduces disease morbidity and mortality, averts health care costs, prevents parents' and caregivers' lost wages from having to care for their sick child, and supports student academic achievement.[117] Vaccines provide safe and effective protection against many infectious diseases. The Advisory Committee on Immunization Practices (ACIP) recommendations for child and adolescent immunization schedules by age are found here and reflect studies of effectiveness that are described elsewhere. The American Academy of Pediatrics, the Centers for Disease Control and Prevention, the World Health Organization, and other scientific bodies recommend scheduled childhood vaccination including vaccination against influenza and COVID-19. Studies included in this review that were exclusively focused on vaccination used school located vaccination strategies or focused on increasing parent knowledge and perceptions about vaccination.

Making vaccines easier to access from trusted providers, such as school-located influenza vaccination (SLIV), was assessed as one strategy to improve vaccine uptake in children.[92,100,104,105,109] In an Oakland, California study, city-wide SLIV was associated with higher influenza vaccination coverage and lower Oseltamivir prescriptions (an antiviral medication used to treat influenza) in school-aged children, and lower medically attended acute respiratory illness (MAARI) among people over 65 years in the community.[93] An Arkansas study showed that schools with SLIV were associated with higher influenza vaccination coverage and lower student absenteeism.[96] In a literature review conducted to summarize the impact of SLIV, student influenza immunization coverage ranged from 35% to 86%, and all studies found a reduction in absenteeism for influenza vaccinated students.[100] In addition, the study also suggests that SLIV in elementary schools may reduce absenteeism in middle schools and high schools in the same county. A number of other studies found that SLIV raised vaccination coverage in schools.[93,107,112] Additionally, studies showed that students that participated in SLIV programs had lower rates of influenza indicators[93,107] and absenteeism.[92,102,109]

In some studies, parent attitudes were also assessed, and findings were used to create tailored vaccine promotion interventions for parents.[107,111,118] A study conducted in rural Georgia tested an educational brochure for parents. The brochure was intentionally designed to address concerns about vaccines among a predominantly African American community. Parents who participated in the intervention reported significantly higher influenza vaccination rates for their adolescent children compared to the control group, increased influenza vaccination rates post-intervention, and greater intention to have their adolescent vaccinated against influenza in the coming year. Intervention parents also reported significantly higher levels of perceived benefits to vaccination, fewer barriers to influenza vaccination, and higher social norms surrounding influenza vaccination.[118] In another study conducted in Georgia, researchers found that parents who had higher attitude scores toward influenza vaccine were five times as likely to report their adolescent had ever received influenza vaccine compared to parents who had lower attitude scores.[111]

Ventilation

Summary of Findings. Viral particles spread between people more readily indoors than outdoors. School buildings in particular often have high crowding indexes (number of people relative to the size of the confined space) and long exposure times, which can increase spread of infectious disease.[119] Indoor ventilation practices can reduce viral concentrations and overall viral exposure.[120] The studies included discussed two types of ventilation strategies: 1) mechanical ventilation that uses fans, air conditioners and/or air filter machines, and 2) natural ventilation that is achieved by opening windows.[119,121-123] Most studies that assessed ventilation were part of multicomponent interventions. Italian researchers studied the strength of the association between mechanical ventilation and COVID-19 transmission among students in 10,000 classrooms with an average occupancy rate of 20 students per classroom. Of these classrooms, 316 were equipped with mechanical ventilation units (MVU) that were turned on before classes started and maintained throughout the school day. The relative risk of infection for students in classrooms with mechanical ventilation units decreased by at least 74% compared to classrooms with only natural ventilation.[119] A Rhode Island study conducted during the COVID-19 pandemic observed that the lowest classroom particulate matter (solid particles and liquid droplets in the air) concentrations occurred when both a fan and portable high-efficiency particulate air filter (HEPA) air cleaner were used simultaneously, which can potentially contribute to a reduction in infectious disease transmission.[121]

Researchers in Virginia studied a model of natural ventilation on buses.[46] Buses were required to open the two windows in the middle row and two windows in the last row of the bus by one inch. Mask-wearing and physical distancing of at least 2.5 feet was also required. There was no evidence of COVID-19 transmission during bus transport with two-thirds of bus routes at full student capacity and during the highest community incidence rates of COVID-19. Ventilation via open windows may have significantly contributed to the absence of COVID-19 spread. In another school bus study conducted in Colorado, the use of a dilution ventilation strategy included running the bus's defroster, opening two ceiling hatches (with a powered fan on the rear hatch), opening the driver window four inches, and opening every other passenger window by two inches.[123] This strategy allowed for the highest air changes per hour (ACH) in a moving bus as measured by a carbon dioxide tracer gas decay method as compared to a less comprehensive ventilation strategy. The study found that the level of ACH that can contribute to reduced airborne transmission is achievable in school buses.

Mask Wearing

Summary of Findings. Mask wearing is an effective component of infectious disease prevention strategies, particularly for respiratory diseases and when community transmission rates are elevated.[124-134] Masking effectiveness is dependent on a number of factors, including type of mask, mask fit, and wearing the mask at all recommended times. Many studies assessed masking effectiveness on transmission as a single prevention strategy. Researchers in Massachusetts had the opportunity to examine the effectiveness of mask-wearing in a natural experiment.[127] In February 2022, Massachusetts rescinded a statewide universal masking policy in public schools; however, Boston school districts sustained masking requirements until June 2022. Before the statewide masking policy was lifted, trends in COVID-19 incidence were similar across school districts. After the policy was lifted, COVID-19 incidence was substantially higher in school districts without masking requirements than in school districts that sustained masking requirements. A similar study was conducted in Texas where the state removed masking mandates prior to the 2021– 2022 school year,[129] but some public school districts began the 2021– 2022 school year with mask mandates in place. School districts that maintained school mask mandates experienced fewer weekly COVID-19 cases than those without mask mandates.

When high mask-wearing compliance exists, quarantine for students and staff who have been exposed to infectious disease may not be needed. A Nebraska study found that the elimination of quarantine after mask-to-mask exposure to COVID-19 by K-12 students and staff was not associated with secondary transmission, suggesting that masks were protective against transmission.[13] A county-wide study in Wisconsin reported similar findings in a county that implemented a modified quarantine policy.[23] When a COVID-19-infected student and an exposed student were masked, the exposed student could continue to attend school. At least 87% of middle and high school students were reported to have mouths and noses covered at all times. The strategy did not result in onward transmission of COVID-19 when masked. In a nationwide study of U.S. high school athletes that examined the association between face mask use and COVID-19, researchers also found that face mask use was associated with a lower incidence of COVID-19 among athletes participating in indoor sports, and masks may be protective in outdoor sports when there is prolonged close contact among athletes.[134]

Physical Distancing and Cohorting

Summary of Findings. Physical distancing (also referred to as "social distancing") was a strategy of most multicomponent IPC approaches in the studies reviewed.[135-137] Increasing the distance between individuals can reduce the likelihood of infectious disease spread and has been used as a strategy in both influenza and COVID-19 pandemics.[135-138] Few studies captured in this review examined the impact of physical distancing on infectious disease transmission as the only intervention. As such, it is difficult to determine the impact distancing may have on infection transmission, independent of other mitigation strategies. However, the following studies did have a focus on physical distancing or cohorting as part of multicomponent interventions. In a Massachusetts study, researchers examined whether or not there was a difference in COVID-19 case incidence among K-12 students and staff maintaining three versus six feet (the recommendation) of physical distancing.[137] The study showed no difference in COVID-19 case incidence between three versus six feet, after controlling for other mitigation methods including masking. Similar findings were reported in Virginia,[52] Switzerland,[77] Belgium,[139] and Germany.[41] Schools may also utilize outdoor spaces to increase the amount of physical distancing possible. A study of Minnesota high school athletes found that athletes competing in outdoor individual sports (e.g., alpine skiing and tennis) had less risk of a COVID-19 positive test compared to age-matched athletes competing in indoor sports (e.g., basketball and hockey) .[49]

Multiple studies examined the use of cohorting which limits student interaction into smaller units to reduce potential exposure to respiratory viruses. Cohorting can be a strategy to implement when space is limited in a school setting. One study that examined a community surge in 48 Virginia elementary schools found that no COVID-19 spread was detected between student cohorts.[52] Another study examined the relationship of reopening schools in the UK that involved use of small student cohorts, combined with other strategies. The community infection rates were at the lowest in the UK.[136]

Symptom Monitoring

Summary of Findings. Taking student and staff temperature and assessing a student for signs of illness at school are other methods of symptom monitoring that were discussed in a few studies. This type of strategy is not equivalent to screening testing, as it does not use testing materials to assess if an illness is present or not. School-based symptom monitoring or screening by taking student and staff temperature does not appear to be sensitive for COVID-19,.[27,47] Symptom screening can also pose a challenge for children with allergies (non-infectious) as they often have symptoms that are similar to respiratory infections.[34]

Testing

Summary of Findings. Generally, studies reported that implementing a screening program through testing helped schools conduct real-time surveillance and make informed and timely decisions about the selection and implementation of additional IPC strategies.[77,79,140-151] Across studies that included screening tests, protocols varied. For example, different biomarkers were used for testing and included saliva, buccal, throat, nasal, or hand swabs, cough plates, and/or blood samples. The frequency of testing across the studies also varied from daily to weekly or longer. Some studies examined individual samples, others used pooled samples, and some testing protocols were universal (all students and staff were tested regardless of symptoms), while others tested only symptomatic individuals.[37,140,150]

Although not strictly a screening program, other approaches to testing were used to monitor students exposed to an infectious disease, with the goal of keeping those students in school if they tested negative. During the 2021 fall semester, the CDC collaborated with four states to evaluate how test-to-stay (TTS) in school protocols affected the transmission of COVID-19 in 51 schools across four school districts in four states (GA, IL, KY, NM).[145] Test-to-stay eligible persons were defined as individuals who were not fully vaccinated and were within three feet of a COVID-19 case for at least 15 minutes over 24 hours. These individuals were tested regularly for seven days following exposure, and could remain in school if tests were negative, they remained asymptomatic, and adhered to the school's prevention measures. The TTS strategy was estimated to save an estimated 976 to 4,650 in-person learning days by avoiding unnecessary quarantine among the 2,520 participants across 51 schools. In a study conducted in Illinois, a TTS strategy, that also included masking and physical distancing, resulted in low secondary transmission of COVID-19 in K–12 schools.[43] The researchers highlighted the usefulness of TTS to limit school-based transmission and sustain in-person learning. Another study conducted in England randomly assigned schools to quarantine for ten days (control schools) or to voluntary daily testing for seven days while remaining at school (intervention schools) for students who came in contact with a person who tested positive for COVID-19.[69] There were similar rates of symptomatic infections among students and staff with both approaches.

TTS studies highlighted that there was little transmission in schools, with the use of other strategies including masking and distancing. Few secondary cases were identified among those who participated in TTS. These findings could be used to highlight the importance of layered approaches.

Contact Tracing

Summary of Findings. Contact tracing is an effective public health strategy that has been used to investigate many types of disease cases such as measles and tuberculosis and their potentially exposed contacts.[152] Contact tracing can uncover index cases, increase understanding of how the infection is being spread, and prevent secondary and tertiary transmission cases. No studies in this review evaluated the effectiveness of contact tracing as a standalone strategy for use by schools. Contact tracing was often used as part of a larger multicomponent prevention strategy.[15,27,50,68,72] This strategy, in many studies, was coupled with testing or test to stay to help reduce the spread of COVID-19.

School Operational Status

Summary of Findings. The findings on school closure and its effect on the transmission of respiratory and gastrointestinal infections were mixed.[139,153-169] The studies included in this review included the following types of approaches: school closures (with or without virtual learning) and subsequent reopening; hybrid learning (only a portion of the school attended in person or on a particular day to reduce the total number of students in the school building). Studies examined the effectiveness of these approaches on infection transmission. The mixed findings may be explained by multiple confounding variables such as infection type, viral reproduction rate, community incidence at the time school closure is enacted, the timing of school closure (proactive or reactive), social contacts outside of school, implementation and compliance with NPIs at school (e.g., masking), age/grade level, and vaccination coverage at the time of the study. In addition, some studies that used testing to determine infection rates were voluntary and not everyone in the intended study population participated. All of these factors could have had influence on the effectiveness of school closure.

During the 2009 H1N1 influenza outbreak in New York City, schools with high rates of influenza-like illness (ILI) were closed for one school week.[157] On average, school dismissal reduced the rate of ILI by 7.1% over the entire average outbreak period; however, a large proportion of the ILI cases occurred *before* the closing of schools. A Kentucky study reported that reactive school closures (after the disease has spread widely in the community) are often too late to reduce influenza spread and cause difficulties for learners and households and that proactive school closures are difficult to time to make an impact on transmission.[165] A study conducted in Arizona found scheduled school closures for winter break delayed up to 42% of potential influenza cases among school-age children, providing evidence that school closure can be used as an intervention to slow the spread of infectious disease outbreaks.[169]

Several studies concluded that keeping schools open when COVID-19 incidence increases in the community may be a safe option when appropriate IPC measures are implemented at schools.[27,44,62]

HEALTH EQUITY, INCLUSION, AND ACCESS TO SERVICES

School settings can have a pivotal role in ensuring equitable access to learning, healthcare, and other support services. Health equity practice in infection prevention in school settings requires that decisionsrelated to IPC prevention strategies address disparities in health outcomes and do not disadvantage any group of students or school staff.. Similarly, under-resourced school districts often face challenges in maintaining school infrastructure, securing financial resources, IPC equipment, and other supplies.[43,45,67,145,147,162]

Health equity is the state in which everyone has a fair and just opportunity to attain their highest level of health. Achieving this requires focused and ongoing societal efforts to address historical and contemporary injustices; overcome economic, social and other obstacles to health ahd healthcare; and eliminate preventable health disparities.

Centers for Disease Control and Prevention. Office of Health Equity. [What Is Health Equity?]() February 12, 2023.

Within this review, researchers in several of the studies committed to reflection design and purposive sampling as ways to examine health equity.[56,151] In the interest of health equity and positive outcomes, there is greater scientific rigor when study participants reflect populations, such as people living in rural areas, people with disabilities, immigrants, American Indian/Alaska Native, Black or African American, and Hispanic or Latino populations, religious groups, youth in foster care, juvenile centers, or unhoused youth, and students receiving special education services.

Additionally, studies indicate that decision-makers consider the following examples as opportunities for health equity practice for IPC in K-12 schools: low and no-cost strategies; ensuring that interventions can be replicated with minimal barriers to implementation; equitable information sharing, such as providing written and verbal communication in multiple languages;[29] inclusive vaccination programming, such as efforts to increase vaccine confidence and uptake;[102,103,118,170] cost-effective vaccination and access for uninsured and under-insured students and families;[66,92,102,105,107,108] and adequate resources and funding for school-based vaccination programs.

Overall, best practices in health equity and infection prevention are grounded in community engagement,[143] feasibility, and resource allocation[145] and require that comprehensive prevention strategies are in place to keep students, staff, families, and school communities safe and provide supportive environments for in-person learning.

LIMITATIONS OF THE STUDIES REVIEWED

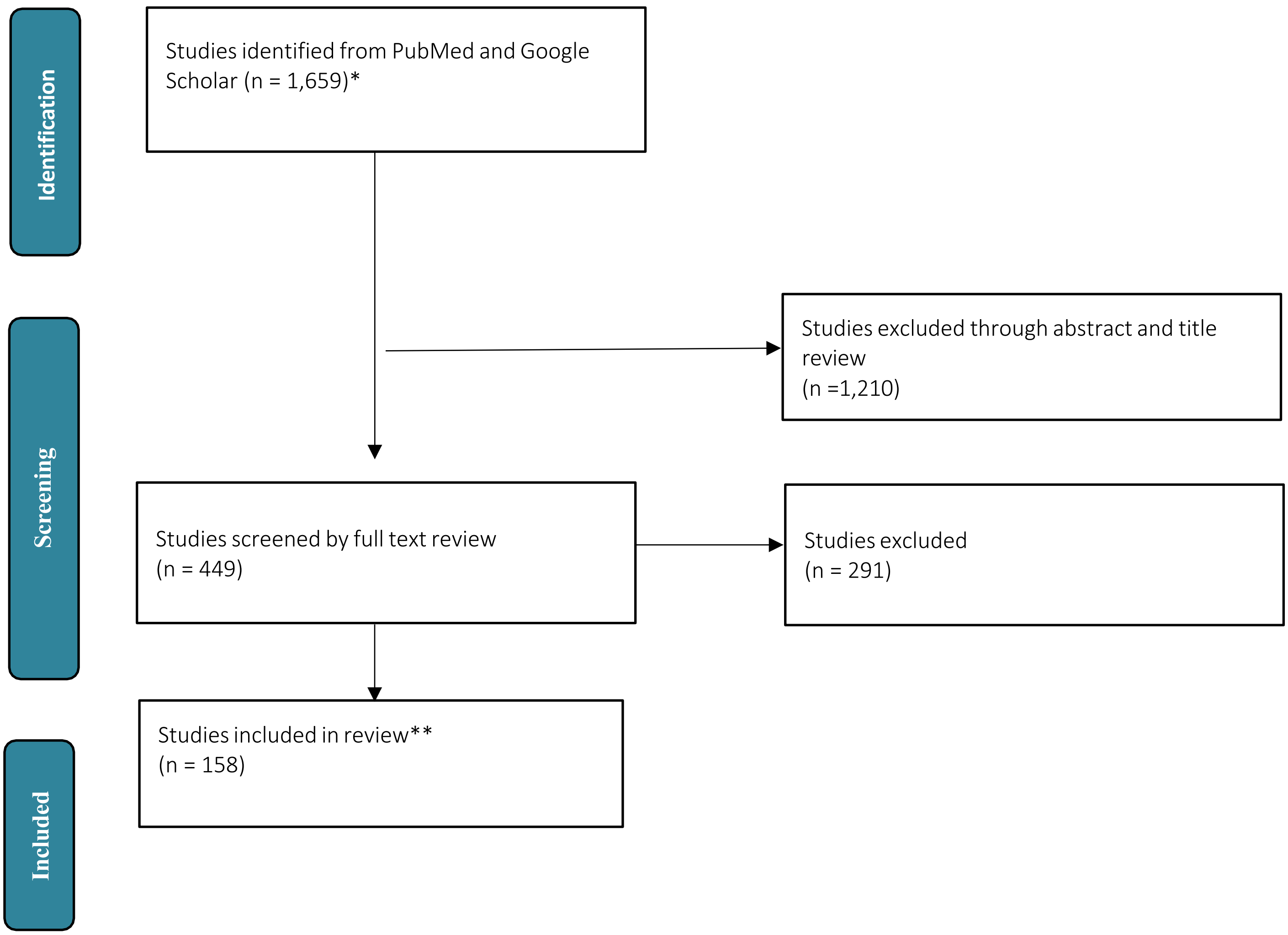
The 158 studies reviewed for this science brief varied by study design, sample size, measured outcomes, and data analyses. Some studies measured changes in infectious disease rates or student absenteeism or both. Others measured changes in the uptake or quality of the mitigation behavior or practice. In some studies, participation in an intervention such as vaccination and testing were voluntary and the actual sample sizes were relatively small. In other cases, the intervention was implemented inconsistently due to various challenges. The majority of studies were multicomponent, and therefore, did not specifically assess effectiveness of a single intervention strategy, making it challenging to conclude the impact of single strategies.

CONCLUSIONS

Schools have a critical role in preventing infectious diseases and ensuring the health and safety of students, staff, and the wider community. Developing a science-informed emergency operations plan with an infectious disease section plan is the first step in playing this critical role. Standard precautions like handwashing, staying home when sick, respiratory etiquette, regular surface cleaning and disinfection, and ventilation can help decrease infectious disease transmission and are relatively inexpensive and feasible to implement daily. Vaccination is a proven public health intervention; schools can support vaccination uptake by supporting school located vaccination efforts as well as tailored education interventions for parents and families. In times of outbreaks, additional measures such as mask-wearing, physical distancing, and testing may be indicated. Based on the studies in this review, multicomponent or layered IPC approach gives the most protection against infectious illnesses, including influenza, COVID-19, and gastrointestinal diseases. It is important for future research studies to examine the role of both singular strategies and the role of each strategy in multicomponent interventions. Finally, additional studies that examine the implementation barriers, challenges, and facilitators as well as approaches for IPC strategy implementation will add value to the existing body of literature.

APPENDIX A

PRISMA Flow Diagram for Infection Prevention and Control Science Brief



*Key words include “School and”: “infection control/prevention”, “respiratory disease”, “ventilation”, “absence and infection”, “illness exclusion or absence for illness”, “disease transmission”, “mask wearing”, “disinfection or cleaning”, “gastrointestinal disease”, “hand washing”, “vaccine or vaccine promotion” **Study inclusion criteria were: publication type (peer-reviewed journal articles), publication date (2009-2023), study countries (United States, Canada, United Kingdom, European Countries, Australia, & New Zealand), publication language (English only), setting (school-based), participants (K-12 school students, staff, and parents/guardians), study design (Randomized controlled trial, quasi-experimental, case-control, cohort, cross-sectional, mixed methods), and study aims (examines an association between a school- based prevention strategy or intervention and: 1) respiratory or gastrointestinal infection or 2) absence rate outcome among school staff or students)

APPENDIX B

Article Extraction Form

FULL CITATION

1. **Full Citation**

   (write in)

2. **Setting – Country** (check all that apply)
- US
- UK
- Italy
- Spain
- Belgium
- Australia
- Other

3. **Setting – Geographical Type** (check all that apply)
- Rural
- Suburban
- Urban
- Not stated

4. **Setting – U.S. HHS Region**

   (drop down)

5. **Setting – School Type** (check all that apply
- Elementary
- Middle School
- High School
- Alternative School
- Other

6. **Setting – Specific School Areas** (check all that apply)
- All school/whole school building
- All classrooms
- School Bus
- Cafeteria
- Sports
- Chorus/Music
- Extracurricular

- Other
- Not identified

7. **Other Comments about Setting Context (e.g., poverty)**
(write in)

INTERVENTION DESCRIPTION

8. **Intervention Type** (check all that apply)

A. School Attendance
- School closure
- Hybrid (some in-person, some remote learning)
- Stay at home/Quarantine if sick

B. Clinical
- Vaccination
- Testing

C. Individual Behaviors
- Masking
- Respiratory etiquette
- Social distancing
- Handwashing
- Hand sanitizer

D. School Building
- Surface cleaning/disinfection
- Ventilation

E. Education
- Education – Written Materials
- Education in Classroom – Students
- Education Other Format – Students
- Education – Parents
- Professional Development – (Faculty, Staff, etc.)

F. Policies

G. Other

9. **Brief Description of Intervention**
(write in)

10. **Who Implemented the Intervention** (check all that apply)

- School Administration
- School Faculty
- Local Government
- State Government
- Outside Community Organization
- University or Research Institution
- Other

11. **Implementation Challenges/Barriers**
(write in)

12. **Implementation Facilitators/Enablers**
(write in)

13. **Other Comments on Intervention Feasibility/Acceptability**

(write in)

SAMPLE DESCRIPTION

14. **Sample Size**
- 1-50
- 51-200
- 201-500
- 501-1000
- >1000

15. **Participant Type** (check all that apply)
- Faculty
- Staff
- Administrators
- Clinically Affiliated Staff
- LEA, SEA Level
- Parents/Guardians/Family
- Community/School Partners
- Students
- Other (describe)

16. **Participant Demographics**
- White %
- Black or African American %
- American Indian or Alaska Native %

- Asian %
- Native Hawaiian or Other Pacific Islander %
- Hispanic/Latino Ethnicity %
- Other

17. **Participant Grade** (check all that apply)
    - Grades K-2
    - Grades 3-5
    - Grades 6-8
    - Grades 9-12
    - Not identified

18. **Other Comments about Sample (e.g., poverty)**
    (write in)

EVALUATION AND FINDINGS DESCRIPTION

19. **Type of Evaluation** (check all that apply)
    - RCT
    - Quasi-Experimental
    - Cohort
    - Case-Control
    - Mixed Methods
    - Other

20. **Evaluation Duration**
    - Less than or equal to 1 month
    - Longer than one month, less than or equal to 3 months
    - Longer than 3 months, less than or equal to 6 months
    - Longer than 6 months

21. **Describe Significant and/or Insignificant Intermediate OUTCOME Changes**
    (write in)

22. **Significant IMPACT(S)** (check all that apply)
    - COVID
    - Influenza
    - Other URI
    - GI
    - School Absence
    - Other

23. **Describe Significant and/or Insignificant IMPACT Changes**

(write in)

24. **How did the intervention affect health equity, inclusivity, and/or access to services, if at all?**
    (write in)

OTHER NOTES/COMMENTS

25. **Other Notes/Comments**
    (write in)

Appendix C

Intervention Strategy Descriptions	
Strategy and # of Studies that Included It	**Brief Description**
Multicomponent / Layered Approach (99 Studies)	A multicomponent or layered intervention is one that includes two or more IPC strategies.
Hand Hygiene (Hand Washing / Hand Sanitizing) (30 Studies)	Handwashing is the scrubbing of hands, (top and bottom of hands, between fingers and nails) with clean water (warm or cold) and soap for at least 20 seconds. Hands should then be rinsed with water and dried with a clean towel.
Respiratory Etiquette (9 Studies)	Respiratory etiquette includes covering one's mouth and nose during coughs and sneezes, turning away or walking away to cough or sneeze, throwing away used tissues, and handwashing or using hand sanitizer after touching the mouth and nose.
Surface Cleaning / Disinfection (17 Studies)	Cleaning with soap and water decreases the number of germs on surfaces and reduces risk of infection from surfaces such as desks, learning manipulatives, musical instruments, and sports equipment. Disinfecting with the use of an EPA-registered product can kill harmful germs that remain on surfaces after cleaning. By killing germs on a surface after cleaning, disinfecting can further lower the risk of spreading disease.
Vaccination (36 Studies)	Vaccines are preparations used to stimulate the body's immune response against diseases. Vaccines are usually administered by injection, but some can be administered by mouth or sprayed into the nose.
Ventilation improvements (15 Studies)	Ventilation strategies help reduce the number of viral particles in the air. Ventilation can be achieved by opening windows, using fans, and using air filtering systems.
Mask Wearing (49 Studies)	Masks create a barrier between infected droplets or particles a person breaths out into the air. Masks also help limit the breathing in of droplets that may be put into the air from another person.
Physical Distancing, Cohorting (47 Studies)	Physical distancing means increasing space and distance between individuals. This may mean students staying a certain distance away from each other in a classroom. Cohorting keeps smaller groups of students together to reduce possible exposure to illness.
Testing, Symptom Monitoring, Contact Tracing (56 Studies)	Testing identifies people with an infection who do not have symptoms or known or suspected exposures so that steps can be taken to prevent further spread of the disease. Contact tracing is a public health strategy that can help identify index cases and exposures. Symptom monitoring or screening is the process of assessing symptoms informally or more formally, such as temperature checks.
School Closure including Hybrid Models (51 Studies)	School closure is complete school dismissal. There is no in-school building attendance by students or staff. Remote instruction/distance learning may be put in place. Other school services (e.g., meals) are likely not provided.

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